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Department of Conservation
Water Power and Control Commission

Geologic Correlation of Logs of Wells in Kings County, New York

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Prepared by the United States Geological Survey
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M. L. BRASHEARS, JR.	*District Geologist*

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INTRODUCTION

The many problems pertaining to the ground-water resources of Long Island all involve a consideration of the geology of the island. With a few exceptions, the geologic formations recognized on Long Island do not crop out at the surface, and a study of the geology of the area, therefore, becomes largely a matter of examination of well samples and a study and correlation of well logs.

In 1906 geologic correlations of logs of many wells were published in U. S. Geologipal Survey Professional Paper 44, "Underground water resources of Long Island, New York," by A. C. Veatch and others. Since that time a large number of wells have been drilled on the island and these records, together with those published in Professional Paper 44, have contributed greatly to the understanding of the geology of the island.

Since 1932 the U. S. Geological Survey, in cooperation with the State of New York and with Nassau and Suffolk Counties, has been carrying on an investigation of the ground-water resources of Long Island. A part of this work has consisted of the collection and publication of records of wells that have been drilled since 1906. Tentative geologic correlations of many of these logs have been made during the course of the geologic studies. In order to make these correlations available to interested persons, considerably in advance of the time when a complete report can be issued, it has seemed desirable to release tables and maps showing the correlations for the individual wells.

In 1903 the geology of Long Island was studied and mapped in considerable detail by the U. S. Geological Survey. Two reports were later published giving the results of this work.[1] For many years W. O. Crosby made studies of the geology of Long Island for the Board of Water Supply of the City of New York, although the results of most of his work were never published. There was considerable diversity of opinion between these earlier workers concerning the geologic age and the presence or absence of certain formations. Some of these differences of opinion have been discussed in a more recent paper.[2]

The correlations included in the present report have been made by various members of the Geological Survey since the start of the cooperative investigations in 1932. During the first few years of the investigation, geologic correlations were made by F. G. Wells, D. G. Thompson, and H. R. Blank. On the basis of later and more complete information some of these correlations were revised by R. M. Leggette; M. L. Brashears, Jr.; C. M. Roberts; and the writer, who also made correlations of the numerous well logs and suites of samples that have become available during about the past 10 years. This report, including the maps, tables, and cross-sections, represents the first stage of a systematic restudy and re-evaluation of all the earlier correlations, begun by the writer and Nathaniel M. Perlmutter in 1946 under the direct supervision of M. L. Brashears, Jr., district geologist of the Geological Survey in charge of ground-water investigations in New York and New England.

Type of correlation attempted. The geologic correlation of the many logs of wells and test borings in Kings County contained in the accompanying tables is an effort to group together materials which were deposited at the same time and by a common agency. That is, each of the units has a common geologic origin, related to one stage or chapter in the history of the formation of the island. A variety of materials is present in each of these units and even the more uniform show considerable range in composition and thickness. The units used may consist of part of a geologic formation, as in the case of the Lloyd sand member of the Raritan formation, or may comprise a sequence of several formations, more or less similar in lithologic character, as in the case of the unit here referred to as the "upper Pleis tocene deposits" which includes beds laid down after the close of the Jacob stage.

A genetic grouping of this sort does not serve directly of itself to solve hydrologic problems, but experience has shown that it forms the only valid basis for the start of such a study. The purpose of this report is therefore to provide basic data for the solution of hydrologic problems, not to supply the answers to these problems directly.

The hope that these correlations will be of service in connection with water-supply and related problems has, however, influenced the selection of the units used, as well as some of the correlations themselves. This is explained below in the discussion of the units. Of equal or greater importance in shaping the actual choice of the units used is the fact that virtually all the information is in the form of well logs. Subdivisions of the geologic column must therefore be based on the identification of clay, gravel, sand, and boulders,—data which are to be found in the logs. Distinctions which must be based on a knowledge of mineral content, details of grain size or sorting, or even those which rely on the color of the material, are frequently inapplicable, as this information is not given in most well logs.

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[1]Veatch, A. C., and others, Underground water resources of Long Island, New York: U. S. Geol. Survey Prof. Paper 44, 394 pp., 1906. Fuller, M. L., The geology of Long Island, New York: U. S. Geol. Survey Prof. Paper 82, 231 pp., 1914.

[2]Thompson, D. G., Wells, F. G , and Blank, H. R., Recent geologic studies on Long Island with respect to ground-water supplies: Econ. Geology, vol. 32, pp. 452-462, 1937.

The table and maps in this report include a correlation for nearly all the well logs in the reports of Leggette.[3] In addition, a few of the more important wells from the much older report of Veatch[4] are included. Their logs in simplified form are given in the appendix, as the report by Veatch has long been out of print. In the table and maps all the figures on depth have been changed from those appearing in the original reports, where the datum is the land surface or some nearby point, to elevation above or below sea level. This has been done to facilitate a pomparison between wells even though this complicates slightly a comparison between the published logs and the present correlations.

The type of drilling and the purpose for which a well or test hole was put down influence the reliability of the log obtained, and also the scope or type of information which is contained in it. Certain test holes for instance, K 668, K 676, and K 694[5] were drilled for the purpose of examining the bedrock and were jetted in as far as bedrock. Because little attention was paid to the overlying sediments, these records are of relatively little value to the present study not only because of the method of drilling used, but also because the logs lack detail as to the overburden. The hydraulic rotary drilling method, used to sink the deeper wells of the New York Water Service Corporation, can and usually does provide a somewhat more accurate record of the material penetrated but one that is not completely reliable. A comparison of the records of K 520 and K 533, two deep wells drilled only a short distance apart, shows that in the latter the driller reported simply as "coarse sand" what in the first well had been reported in more detail as several units containing fine sand as well as coarse. There can be little doubt that the record of well K 520 is the more accurate, probably because of more care on the part of driller. However, the rotary drilling action sorts the materials to some extent before they are discharged at the land surface. In addition, the drilling mud used to prevent caving of the well hole masks the samples. Because of these features, logs based on examinations of rotary samples may be misleading.

Wells drilled by the cable-tool method are believed to provide a more reliable record, but even with them, the washing of the samples as they are bailed alters the ratio of fine to coarse material and destroys any evidence of bedding. Caving of the well hole may at times contaminate the samples.

Where it has been possible for a geologist to study samples from a well, or better still, to follow the actual drilling on the site, more reliable and better-evaluated results have been obtained. Few such records are available for wells in Kings County and none for any of the deep borings. Wells[6] examined samples from some of the deeper wells of the New York Water Service Corporation which had been so arranged in glass tubes as to form scale models of the wells, but subsequent work suggests that at least some of these scale models had not been accurately constructed.

Other sources of information. In the case of a few wells, other information in addition to the well logs is available to aid in the correlations. The most useful of these are the water-level measurements which have been made in a number of the wells in the area since about 1932. Some of these records were made with automatic water-stage recorders which have furnished a continuous record of the water level for periods ranging up to 12 years. In a few cases, an abrupt change in pressure in an artesian aquifer due to the sudden starting or stopping of a pump has appeared as a change in water level in one or more widely separated wells. This proves, or at least suggests strongly, that the pumping well and the observation wells are all screened in the same coarse sand or gravel layer, and that this aquifer is overlain by an impervious layer, probably clay, which is essentially continuous over the area affected. Such interference has served to tie together wells K 19, K 921, K 526, K 519, and K 533, which are all believed to be screened in the principal gravel layer of the Jameco gravel.

Wells K 523 and K 525 also appear not to be screened in the principal beds of the Jameco gravel and, as would be expected, do not respond to the changes which are common to the first group. It is believed that these two wells are screened in a higher gravel layer of the Jameco which is separated hydraulically from the principal bed. Well K 521 on the other hand not only fails to show the changes observed in the neighboring wells which are screened in the Jameco gravel, but shows some similarity to the general pattern of the Lloyd wells. The known Lloyd wells, however, are too distant for effective comparison, and the correlation of the gravels in the bottom of well K 521 with the Lloyd sand member of the Raritan formation is not entirely certain.

Well K 1139, located at the New Lots pumping station of the City of New York, for which there is no log but which is known to be screened at 115 feet below mean sea level, has shown interference with well Q 340, situated across the county line to the east in Queens County. The log of Q 340 suggests strongly that it is a Jameco well, thus substantiating the correlation of those wells at the New Lots pumping station for which logs are available (K 538, K 1286) where the top of the Jameco gravel was placed about 110 feet below mean sea level. Marked in-

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[3]Leggette, R. M., Records of wells in Kings County, New York: N. Y. Water Power and Control Commission Bull. GW-3, Albany, 1937; and (with M. L. Brashears, Jr.) Bull. GW-8 (continuation of Bull. GW-3).

[4]Op. cit.

[5]The logs of the wells referred to by number in this report may be found in the bulletins of Leggette cited in footnote 3.

[6]Logs published by Leggette in Bull. GW-3, pp. 90, 96, 98, 100, 101 and 108.

terference has been noted by J. G. Ferris, engineer, U. S. Geological Survey, between some of the Jameco wells farther east in south central Queens County. It may be possible eventually to tie this group in to the main group in Kings County, by means of pumping interference.

Substantiation of the proposed correlation of the few wells in Kings County which are believed to penetrate the Lloyd sand by interference among these wells has not as yet been possible. To the east, in Queens and Nassau Counties, mutual interference has been observed by Leggette[7] in a widespread group of Lloyd wells, and it is possible that one or more of the Lloyd wells in Kings may eventually be related to this group. Some data have already been obtained showing that pumping of well Q 1030 in Queens County, which is known to be screened in the Lloyd sand, affects well K 1057[8], which correlated as a Lloyd well in this report.

Fossils. The Cretaceous deposits of Long Island have yielded relatively few fossils, and well samples in particular have not provided material that could aid in the work of correlation. The Gardiners clay and the Jacob sand, of middle Pleistocene age, have yielded shells and diatoms[9]. Because virtually all of these fossils are similar to or identical with modern forms, no attempt has been made to use them as an aid in separating these two formations from clays and silts of Recent age. The presence of shells in a clay, or in the sand immediately, below a clay, however, is a strong indication that the clay is the Gardiners, because, particularly in Kings County, the Gardiners is far more likely to contain shells than any of the other formations. Farther east on the island, where the Jameco gravel is absent, the Gardiners clay rests directly on the Cretaceous beds, and the Gardiners clay and the Cretaceous beds may be easily confused. Here the presence of shells reported in a log is also an aid in distinguishing the Gardiners from the older clays, but unfortunately the Gardiners here is less fossiliferous than it is in Kings County, and many of the logs make no mention of shells at any depth.

Possible future work. Some thought has been given to other aids in correlation, though no serious work has as yet been attempted. In the case of wells for which reliable samples are available, heavy-mineral studies might serve to trace certain beds for limited distances, but there is at present no reason to hope that any new mineralogical criteria exist which could serve to distinguish any of the broader units over wide areas. The presence of unweathered biotite, hornblende, feldspar, and similar easily decomposed grains has long been regarded as evidence of Pleistocene age, while a composition limited to quartz, clay, and flakes of deeply weathered muscovite is typical of the Cretaceous. In point of fact, where reliable samples are available, the major subdivision can usually be identified with little trouble, and the correlation of new wells as they are drilled is far less of a problem than it is with older wells, where only a driller's log is available.

In Kings County, there will probably be little if any more deep drilling for many years, and there would be considerable interest in getting additional information from any of the old deep wells which are still open and accessible. As they are all cased, electrical resistivity measurements, at least by the conventional methods, cannot be employed. Radioactive logging may be able to give an indication of the distribution with depth of clay or of clean sand and gravel, or possible help in locating the boundary between the Pleistocene and the Cretaceous.

Outline of geology. Long Island consists of three main categories of material. The oldest of these is the pre-Cambrian bedrock which forms the sloping platform upon which rests the material making up the island proper. Although deeply weathered in places, the bedrock may be described as composed of hard, more or less homogeneous and impermeable material. It represents the lower limit of well drilling on Long Island, for the very few wells which have been sunk into bedrock in search of water have met with little success.

The bedrock is overlain by Cretaceous deposits except in northwestern Kings and Queens Counties where deposits of this age have been removed by erosion. The Cretaceous material belongs to two formations of Upper Cretaeous age. (See table 1, stratigraphic sequence for Long Island), the Raritan formation, which has been satisfactorily correlated with the type area in New Jersey, and material believed to be the equivalent of the overlying Magothy formation, for which a similar correlation has not as yet been accepted. The Raritan has been subdivided into the Lloyd sand member, composed largely of coarse white quartz sand and gravel, and an overlying clay member. Although the Lloyd is the source of considerabie water in Queens, Nassau, and Suffolk Counties, only two of the few wells in Kings County which are screened in it are now being pumped. The beds tentatively assigned to the Magothy have never produced water in Kings County, though to the east in Nassau and Suffolk Counties they are heavily pumped. The Magothy is composed of many alternating layers of sand, silt and clay, mixed in varying propostions.

[7] Leggette, R. M., The mutual interference of artesian wells on Long Island, New York: Trans. Amer. Geophys. Union Ann. Meeting, pp. 490-494, 1937.

[8] Jacob, C. E., On the flow of water in an elastic artesian; Trans. Amer. Geophys. Union, pp. 574-586, 1940, and Notes on the elasticity of the Lloyd sand on Long Island, New York; Trans. Amer. Geophys. Union, pp. 783-787, 1941.

[9] Lohman, K. E., Pleistocene diatoms from Long Island, New York; U. S. Geol. Survey Prof. Paper 189-H, pp. 229-237, 1937.

TABLE 1. STRATIGRAPHIC SEQUENCE AND CORRELATIONS OF MESOZOIC AND CENOZOIC FORMATIONS ON LONG ISLAND

AGE	VEATCH	FULLER	CROSBY	PRESENT REPORT
Recent	Post Glacial and Recent	Recent		Recent deposits
Pleistocene	Wisconsin: Harbor Hill Ronkonkoma	Wisconsin: Harbor Hill Ronkonkoma	Glacial	Upper Pleistocene deposits
	Tisbury (Manhasset) gravel	Manhasset: Hempstead Gravel Montauk till Herod gravel		
	Sankaty	Jacob sand Gardiners clay		Gardiners clay (includes Jacob sand if present)
	Jameco gravel	Jameco gravel		Jameco gravel
	Mannetto gravel	Mannetto gravel		?
Pliocene			Sankaty Pensauken Lafayette	
Miocene			Kirkwood Bethpage	
Upper Cretaceous	Higher Cretaceous beds Matawan Raritan	Higher Cretaceous beds Matawan Magothy Raritan	Monmouth Matawan Magothy Raritan Potomac	Magothy (?) formation Raritan formation Clay member Lloyd sand member

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Transition - - - - - -

The Pleistocene deposits, which form the uppermost of the three principal categories, are divided for the purpose of this report into three units. This division is largely based on the presence and identification of the Gardiners clay, which separates the underlying Jameco gravel, rich in dark colored pebbles of igneous rocks, from the overlying assorted tills, sands, and gravels here referred to as upper Pleistocene deposits.

The Jameco gravel is an important source of water in Kings County. The Gardiners clay, if the present correlations are correct, is not tapped by wells in Kings County, although it contains a few stringers of gravel. The sands and gravels of the upper Pleistocene deposits are the source of most of the water withdrawn in the county.

Procedures used in the correlations. The files of the Geological Survey contain many tentative correlations for well logs for Kings County, and for all of Long Island, which have been worked out by the various geologists who have studied the area. Many of these, considering the island as a whole, are based on the personal observations of samples or of the actual drilling operations, methods which provide a far better opportunity for judgment than the written records of the driller. On the other hand, the worker today has an advantage in that the records of more wells are now available for study, and he is therefore in a better position to trace beds and structures by a comparison of logs. The correlations in this report are consequently the result not only of a study of the record of each individual well, but also of the regional picture as developed by a series of cross-sections and maps. The reliability of the correlations is therefore not simply a function of the scope and accuracy of the data available for each individual well, but depends also on the correctness of the broader analysis. For this reason something of the geologic history is included with the following descriptions of the correlation units.

DESCRIPTION OF THE CORRELATION UNITS AND THE CRITERIA USED IN THEIR IDENTIFICATION

Pre-Cambrian Rocks. The pre-Cambrian bedrock of Long Island consists of a variety of rock types, of which gneiss and schist are the most abundant. In Kings County these rocks have been intruded by sheets and sills of granodiorite and pegmatite and possibly also by dikes of diabase (trap) similar in appearance and possibly of the same age as those of the Palisades of New Jersey. (See record of well K 514 by Wells.) These distinctions between rock types have but little bearing on the problem of determining bedrock in well records, and do not concern at all the problems of water supply.

Bedrock commonly is correctly identified as such by the driller, but problems arise in certain cases that may demand judgment and a comparison with the records of other wells. In the areas where the bedrock is overlain by Cretaceous deposits, the bedrock itself is weathered, deeply in some places but much less so in others. The product of this weathering is commonly clay or a mixture of clay and partially decomposed rock and mineral fragments. This material may be reported by the driller as clay, as weathered bedrock, or as any one of a variety of things, depending on the nature of the material and the nomenclature used by the particular driller. For example, the notation in the next to the last line of the log of well K 532 reads "Hardpan—soft shale"; and the 23 feet of this material together with the following 45 feet, described as "rock—decomposed granite", is here all correlated as weathered bedrock. In other cases, such as well K 534, the position of the upper surface of the weathered bedrock is a matter of conjecture. In general, the logs in this area suggest a depth of weathering of about 10 or 20 feet.

Deeper weathering and a puzzling problem are represented in the cases of six wells, K 461, K 670, K 672, K 673, K 677, and K 678. Well K 620 is at the site of shaft 14A of Tunnel 2 of the Board of Water Supply of the City of New York. H. R. Blank was able to make a detailed study of the material exposed in place in the walls of this shaft, as well as of the walls of the other shafts of tunnel 2. His unpublished notes[10] show that the bedrock at shaft 14A was overlain by a little more than 10 feet of weathered bedrock, in which there was a progressive change upward from fresh rock to clay with more and more of the minerals showing kaolinization. The clay in turn was overlain by 10 or 12 feet of what Blank called "concretionary sandstone", though only a small proportion of residual quartz was present in what was essentially clay, formed by the nearly complete decomposition of the bedrock. The color of the material, depending on the degree of oxidation, was eith er green or red, and commonly showed dark-red or black nodules in a greenish-gray ground mass. The concretions, which were apparently of much the same composition as the body of the clay, ranged in size from tiny oolites to nodules more than an inch in diameter. Many if not all had been indurated by carbonate. The top of the "concretionary sandstone" which Blank in his field notes referred to as "potato rock", contained hexagonal lumps which were interpreted as the result of mud cracks. The whole 10 or 12 feet of concretionary material, according to Blank, consisted of weathered bedrock, because it graded into fresh bedrock without any break and showed just such changes in mineral content as weathering produces. The concretionary texture, Blank felt, was the result of the lateritization of a soil zone of late Jurassic or early Cretaceous age. This weathered bedrock was overlain at shaft 14-A by 5 feet of red and gray clay beds, a sedimentary deposit which Blank believed to be of Cretaceous age. The peculiar weathering and the preservation of Cretacious material in this area have not been fully explained.

Similar materials were penetrated, or at least it would so appear from the logs, by the other five wells listed above. The other localities show, however, a somewhat greater thickness of supposed Cretaceous deposits. Blank reported that "concretionary sandstone" was seen in wash samples from some of the other wells in northern Brooklyn, where it was interpreted as capping low buried hills of the bedrock.

None of this material could have been properly identified as weathered bedrock without the opportunity to examine some of it in place. This is not possible in the case of a drilled well, and occasional confusion of weathered bedrock and sediment seems inevitable, though the thickness of material involved in such an error will probably never be great.

In areas where the Cretaceous cover has been entirely removed by erosion, a different type of error must be guarded against in the determination of bedrock. Drillers using any type of drilling equipment are prone in some degree to mistake a large boulder for bedrock—or, for the same reason to report bedrock, when actually reached, as possibly a boulder. The Cretaceous deposits do not contain boulders, but the Pleistocene deposits, particularly those included in the upper Pleistocene, contain many. The confusion is particularly difficult to resolve where glacial material rests on the bedrock, for the bedrock surface in these areas has been so irregularly eroded that it is very difficult to predict at

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[10]Brief logs for three of the shafts, abstracted from unpublished studies by H. R. Blank for the New York Board of Water Supply, are given in the appendix.

what depth it will be reached. Part of this erosion is believed to be the result of melt water cascading from the glacial ice itself when it lay in this area, and part from normal stream erosion following, roughly at least, the line of the present East River. The abandoned plunge pools and scour marks do not form a regular pattern, and undrained pockets were also formed, so that the depth to bedrock in these areas varies widely in an unpredictable manner.[11]

Upper Cretaceous deposits. Although it is generally possible to distinguish between the two upper Cretaceous formations, the Raritan or the Magothy, this is not always the case, and some of the general characteristics of the Cretaceous materials are therefore worth emphasizing.

By far the most important characteristic of the Cretaceous deposits is the absence of such easily decomposed mineral grains as biotite, hornblende, augite, and the feldspars. As grains of some or all of these minerals are present in the Pleistocene deposits, their lower limit is commonly taken as the Pleistocene-Cretaceous contact. In the case of well samples, the possibility of contamination by material fallen from above must be guarded against.

All or virtually all of the Cretaceous deposits contain grains or small pieces of much-altered wood or vegetable matter. This material is commonly referred to as lignite. In appearance it suggests charcoal as it is dull black, porous, weak, and crumbly. It crushes to powder easily if tested with a knife point, and may be distinguished in this way from the dark mineral grains found in the Pleistocene deposits. It is widely distributed in small amounts so that a careful search will reveal a few grains in almost any Cretaceous sample. In a few places, thin layers in the Cretaceous have been found in which, locally at least, this lignitic material is the major constituent. Woody material, more or less altered and some of it resembling the lignite described above, is found in some of the clays and sands of Pleistocene and Recent age. Although the presence of such material probably would not lead a geologist to confuse the Cretaceous with any of the younger formations, it does represent a possible source of confusion in the interpretation of logs compiled by well drillers. It cannot be said, therefore, that the reported presence of lignite, charcoal, or woody material assures that the sample is from the Cretaceous beds.

Color, by itself, is of little help in distinguishing the Cretaceous, although in connection with other factors it can offer some aid. The characteristic greensands of New Jersey are not found on Long Island, but a reported green color in a sand is none the less taken as suggesting a Cretaceous age. In the case of clays in the three western counties of Long Island a red color is regarded as evidence that the material is Cretaceous, and probably of the Raritan formation. An example of this may be seen in the correlation of wells K 677 and K 679, where the top of the Cretaceous was placed in part by the reported red color of a clay layer.

In parts of the eastern half of Long Island the Gardiners clay is red. The explanation has been advanced that the color here is due to the proximity to the Triassic redbeds on the mainland to the north, which may well have supplied part of the material from which the Gardiners clay in this area was formed.

The presence of light as against dark-colored clay also suggests the Cretaceous as opposed to the younger units, and this distinction may aid in defining the Raritan formation. An example of this may be seen by comparing the log and correlation of well K 532.

Although color is more likely to be noted by a driller than is the nature of the mineral constituents, there is considerable variation in terminology, so that caution is required. This is particularly true of wells drilled by the rotary method, for the drilling mud generally used on Long Island is red in color, and thus may mask the color of the drill cuttings brought to the surface.

Raritan formation—Lloyd sand member. The Raritan formation of Upper Cretaceous age overlies the bedrock over most of Long Island and much of Kings County. It here consists of two members, an upper clay member to which no special name has been attached and a lower member known as the Lloyd sand. The Lloyd sand was originally definied by Veatch[12] as a thick bed of sand and gravel lying near the base of the Raritan formation. Not in Kings County, but in other parts of Long Island, clay and sand have been reported as occurring between the Lloyd and bedrock. It is believed, though it is not certain, that these deposits are either weathered bedrock or a misrepresentation on the part of the driller. Until evidence is found that proves otherwise, the Lloyd sand may be regarded as the "basal conglomerate" of the Cretaceous on Long Island.

The Lloyd consists of beds of coarse white quartz sand and gravel, separated by one, two, or in some places even three thin clay partings. Hydrologically it appears to act as a unit. The Lloyd is present in only six of the wells listed in the attached table, and in none of these does a typical section of the sand appear. Farther east on the island a maximum thickness of more than 250 feet has been observed. A thickness of 100 feet is more usual in Kings County, and in a few places it is much less. Available evidence for Kings (see sections in pl. 3) suggests that at the southern edge

[11] deLaguna, Wallace, and Brashears, M. L., Jr., Configuration of the rock floor in western Long Island, N. Y.: U. S. Geol. Survey mimeographed report, p. 13, 1946.

[12] Op. cit., p. 19.

of the county, beneath Jamaica Bay and Coney Island, the thickness is 150 to 200 feet, but the beds appear to thin rapidly to the north, and pinch out along a line defined roughly by the position of Fort Hamilton Parkway and Jamaica Avenue (B-6 to R-16). Apparently the sand is not present in the northern half of the county. The clay of the Raritan formation overlaps the Lloyd sand member and extends an appreciable distance inland up dip to the northwest, suggesting that the present edge of the Lloyd may well represent the limit of original deposition. As yet there is no evidence of an unconformity between the Lloyd sand member and the clay member of the Raritan, as there would be if there had been erosion of the Lloyd prior to the deposition of the clays. If this is the case, then the correlations of such wells as K 528, K 532, and K 514, which show clay of the Raritan resting directly on bedrock, indicate that the Lloyd was never deposited at these locations.

The upper surface of the Lloyd slopes to the southeast, as do almost all the beds on Long Island, partly because the surface on which it was deposited sloped in this direction and partly because there has been a subsequent tilting of the land mass. The slope of the Lloyd is difficult to determine in Kings County, as the data are so limited. Over much of western Long Island the slope is roughly 65 feet to the mile, whereas the bedrock has a slope of about 75 or 80 feet per mile. In central and eastern Long Island the slopes are somewhat gentler.

The recognition of the Lloyd and its correlation from well to well are not difficult. Its position between the underlying bedrock and the clay member of the Raritan gives a pattern which is not duplicated elsewhere in the local geologic column. The composition, coarse white quartz sand and some fine sand and interstitial clay, is generally noted and accurately described by the drillers, who are familiar with the unit because it is an aquifer sought and tapped by many wells.

Wells K 524 and K 521 present two most puzzling cases involving the correlation of the Lloyd sand member in Kings County. In the case of well K 524, the gravel encountered between 336 and 349 feet below sea level was correlated as the Lloyd sand member, though this material is at a higher elevation than and is separated from the main body of the Lloyd. The gravel beds penetrated by the bottom of well K 521 were at first believed to be part of the Jameco gravel. In the summer of 1947, however, the New York Water Service Corporation stopped pumping from its many Jameco wells in Kings County and as a result the water level in the Jameco gravel started to rise. Well K 521 alone of the supposed Jameco wells failed to take part in this response. An investigation showed that the water level in this well stood at about 3 feet above sea level while the level in the Jameco gravel in this area is known to be about 20 feet below sea level. The gravel in the bottom of K 521 has therefore been assigned to the Lloyd sand member of the Raritan formation.

The name "Lloyd sand", which is in common use, is misleading in one respect. This terminology implies that the unit is either a formation, or the equivalent of one. As this is not the case, the Lloyd being only part of the Raritan formation, the proper term is "Lloyd sand member".

Raritan formation—Clay member. The clay which forms roughly the upper half of the Raritan formation on Long Island was correlated with the Raritan at its type locality in New Jersey in 1843[13]. The beds are compact and tough, highly impermeable, and commonly appear as a definite unit in the logs of wells which penetrate them. In places there are a few thin silt or sand layers, and also a few beds of partly indurated clay, these last sometimes being reported as "boulders" by the operators of rotary drilling rigs because they make the drill jump and chatter in much the way that boulders would. The clay contains scattered fragments and shreds of lignite and locally small nodules or irregular masses of marcasite, pyrite, siderite, and limonite, though these are seldom reported in well logs and are of little value in identifying the formation. The color of the clay ranges from white to green or black and also from yellow to red. Although the clay member of the Raritan formation averages about 200 feet in thickness in western Long Island, there is considerable variation from this dimension because of uneven erosion of the upper surface of the formation. Where the Raritan is overlain by the Magothy (?), as is true over most of the island, this erosion represents a disconformity between the two formations. How much material was removed at this time is uncertain, but the observed thickness of the clay ranges from about 300 feet to about 50 feet and even greater variations in both directions have been inferred.

In Kings County the greatest observed thickness of the clay member of the Raritan, 221 feet, was recorded in well K 514.

In the case of three wells in Kings, wells K 523, K 531, and K 533 the correlations show Magothy (?) resting directly on bedrock. Although this seems to be the most logical interpretation, the evidence is poor at best and, in the case of the two logs for well K 523 (see Bull. GW-3), it is actually conflicting. If it were possible to prove that the interpretation given is correct, it would have an important bearing on the hydrology of the Lloyd sand. A study of the pressure and direction of the movement of the water in the Lloyd shows that an important part of that water enters in areas where the Lloyd has been regarded as overlain and sealed by the clay member of the Raritan. How-

[13]Mather, W. W., Geology of New York, pt. 1, 1843.

ever, if the Raritan has indeed been completely eroded in parts of Brooklyn, as must be the case if the Magothy (?) rests on bedrock, then Raritan may also have channelways eroded entirely through it in other parts of the island. Such channelways would provide a ready means of recharge of the aquifer.

In Kings County the clay member of the Raritan is present, at most, only in isolated patches (see well K 894) northwest of an imaginary line running from A-9 to R-17 (plate 3), though there is not sufficient evidence to locate this boundary in any but the most approximate manner. The removal of the Raritan from this area is most easily explained as the result of erosion during the late Tertiary and Pleistocene.

Magothy (?) formation. The next unit above the Raritan is the Magothy formation or, more properly, material which is believed to be its equivalent, as the correlation with the type area in New Jersey has not yet been verified. W. O. Crosby[14] was the first geologist to apply the name to any of the beds on Long Island, but he used it for only the lower part of those beds deposited after the Raritan and prior to the Pleistocene, for he believed the upper part of these deposits to be of Tertiary age. This is not at present thought to be the case, and all the beds lying between the Raritan and the lowest Pleistocene, the Jameco gravel or the Mannetto gravel if it can be identified, are now assigned to the Cretaceous and are tentatively referred to the Magothy.

The so-called Magothy in those parts of Queens and Nassau Counties from which the best records are available, has a normal thickness of about 500 feet and a maximum thickness of about 1,000 feet. In parts of southern Suffolk County a still greater thickness may be inferred, for the depth to bedrock and the total thickness of the Cretaceous are both greater there. In Kings County, where the formation is not well developed and where there are few if any reliable logs, the maximum thickness of about 280 feet is found in well K 1056. The formation thins from south to north and wedges out along much the same line as the clay member of the Raritan. At one time it extended much further inland, and the present limit is the result of erosion, as described below under the heading "Tertiary and early Pleistocene history".

The Magothy (?) formation in Kings County is largely composed of beds of fine sand mixed with clay, though beds of clay, coarse sand, and even gravel are also present To the east, where better records are available, the material is thin-bedded, and although the beds show many alternations of fine sand, silt, and sandy clay, no clear-cut large subdivisions are present like those of the Raritan formation. In certain areas some subdivision of the Magothy (?) is possible. However, these zones cannot be traced laterally for any great distance, for they are found to blend indistinguishably into the main body of the unit. In Kings County no subdivisions can be recognized from the present data, and it is doubtful if those which have been noted elsewhere could be identified in this area even if much better data were available.

The minerals present are quartz and clay, with small amounts of deeply weathered muscovite, small scattered grains of lignite, and locally thin plates or nodlues of concretionary limonite or hematite. The general color of the beds is light with mixtures of pale gray, yellow and tan predominating, though a few of the clay-rich beds are dark and are locally streaked with red or orange sand.

In Kings County the upper and lower limits of the Magothy (?) formation are not difficult to establish even in well logs which are lacking in detail, as the contact with the overlying coarse gravels and the underlying clays is fairly well marked. However, in places where the normal sequence is not found, such as at wells K 523 and K 533 where the Magothy (?) appears to rest directly on bedrock, the identification of unit boundaries is not reliable unless a good log is available.

The Magothy (?) is not the source formation for any of the wells in Kings County, although it has been penetrated at a number of places. It seems unlikely that much potable water is available in these beds, although there are large areas in southern Kings where it has not been explored. To the east of Kings, Magothy (?) beds yield large quantities of water to many wells.

Tertiary and early Pleistocene history. A few of the geologists who have studied the geology of Long Island, such as W. O. Crosby, have regarded some of the deposits on Long Island to be of Tertiary age. This opinion is in part due to erroneous determinations of some diatom remains. As no beds have been definitely proven to be Tertiary, deposits of that age are now generally believed to be absent, though the scarcity of fossils makes this by no means certain. There is some reason to believe, however, that Tertiary beds may have been deposited in the area which is now Long Island, inasmuch as physiographic evidence on the mainland suggests strongly that the Cretaceous cover, and possibly also Teritary beds, extend inland 25 to 50 miles north of the present northern limit of Long Island[15]. This implies the later erosion of many hundreds of feet of sediments, probably during the later part of the Tertiary, and at intervals during the Pleistocene.

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[14]Crosby, W. O., Report on the geological relations of the ground water of Long Island: Unpublished report prepared for New York City Board of Water Supply, pp. 4 and 42, Nov. 12, 1910.

[15]Davis, W. M., The Triassic formation of Connecticut: U. S. Geol. Survey 18th Ann. Rept., pt. 2a, p. 155, 1898.

At what time, or under what circumstances, deposition in the Tertiary gave way to erosion is not known, but it seems probable that there was a complex history, with several alternations from one process to the other. Of this history itself there appears to be no record. However, the drainage pattern which resulted, lies today buried under the younger Pleistocene and Recent sediments of Long Island and Long Island Sound. This buried or partly buried system of valleys has been the subject of considerable speculation. Its principal feature is Long Island Sound, which appears to be the drowned valley of a now-vanished stream called the Sound River. The northern side of this valley is the bedrock, and its southern margin the front slope (bajada) of the cuesta formed by the resistant clay member of the Raritan formation. The valley itself appears to have followed the relatively easily eroded belt formed by the Lloyd sand member of the Raritan and the immediately underlying weathered rock. The flow carried by this valley must have been largely formed by drainage from the north, including what are now the Housatonic and Connecticut Rivers, whereas the steep slope of the cuesta face to the south probably provided only a little water. The available records suggest strongly that this valley sloped to the east, for the valley floor appears to be about 100 feet below sea level in northern Queens and about 500 feet below sea level near the eastern end of the island. This implies that the level of the sea for at least part of this period lay 500 feet lower than at present.

Veatch[16] and Crosby[17] both believed, however, that for a part of this period the Sound River, including streams from points as far east as the Connecticut River, drained westward to some point in northern Queens, and then southward through Queens and Kings to the sea. Although Crosby and Veatch did not agree on the exact route of the section of this valley running south from the Sound to the sea, they did agree as to the general picture. They based their belief on a reconstruction of the topography of the post-Cretaceous or the pre-Pleistocene surface as derived from well records for Kings and Queens Counties. These records seemed to show a north-south valley cut deep into this surface. Subsequent work has served to substantiate the existence of the southern end of this valley and in fact suggests that there are two valleys. Neither valley, however, appears to continue as far north as the Sound. This more recent interpretation is based on the records of new wells drilled in northern and western Queens since the work of Veatch and Crosby. These data indicate that the depth to the Cretaceous surface, or the bedrock where the Cretaceous is absent, is little if any below present sea level, where the connecting link of the Sound River Valley is believed to have crossed Long Island. Furthermore, as the data accumulate it is becoming increasingly evident that the area lying between the present Long Island Sound and southern Kings or Queens has not been deeply eroded in post-Cretaceous time. The buried valley, where it is known in Kings, is not over a mile wide and may possibly be narrower to the north, and it is possible to trace out a connection to its supposed headwaters only by means of a twisting and turning pathway which avoids wells and bore holes. However, such maneuvering is becoming increasingly a case of trying to fit the data to the theory. Fuller[18] was of the opinion that the narrowness of the buried channel in Kings and southern Queens showed that it could not have been the outlet for the much wider valley which the trough of the present Sound would have provided. This alone is not a valid argument, for it is commonplace for a stream to have a wide valley where it follows the outcrop of a weak formation, and then to have a narrow valley where it turns and cuts through a ridge of harder material.

The data in truth are not yet adequate for a correct interpretation. The present reconstruction of the post-Cretaceous surface does not suggest that the buried-valley segments in southern Kings and Queens ever carried the flow of the so-called Sound River. The deepest of the valley segments, the one in Kings (shown in pl. 3), extends a little more than 300 feet below the present sea level. This suggests that sea level at the time it was formed was of the order of 400 feet below the present level. As the upper surface of the Cretaceous deposits now is at an altitude of at least 200 feet above sea level in northeastern Nassau County and the adjacent part of Suffolk County, these deposits must have formed a ridge about 600 feet high and with a potential drainage area in northern Nassau and Queens of nearly 100 square miles. If the flow from this area had been channeled to the southwest across southwestern Queens and southern Kings, it alone might have cut the 100 foot-deep valley segments, without the necessity of additional water from a hypothetical Sound River.

The valley segments in southern Kings and Queens are now filled largely with gravel, but also contain beds of sand and clay. This material, part of which at least has been called the Jameco gravel, is an important source of water. The origin and the extent and pattern of the buried valleys are therefore of very real importance in connection with the development of the water in the Jameco gravel.

Pleistocene deposits—Jameco gravel. The Jameco gravel overlies the Cretaceous deposits in central and southern Kings, except for one small area in the vicinity of wells K 894 and K 1273 where it apparently was never deposited. It extends to the northwest, beyond the limit of the Cretaceous, into an area where it rests directly on the bedrock. It probably once covered all of Kings and extended some distance farther to the north and west, and its present limit, marked roughly by the positions of wells K 569, K 663, and K 703, is believed to be the result of erosion. It is overlain by the Gardiners clay which, in the present report, is shown as having about the same distribution.

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[16] Op. cit., p. 31.

[17] Op. cit., p. 59.

[18] Op. cit., p. 57.

The formation is characterized by the dark-colored sands and gravels that comprise the greater part of it. In sharp contrast to the underlying Cretaceous deposits it contains relatively little quartz. It is composed chiefly of fragments of granite, gneiss, and diabase, and particles of the minerals feldspar, biotite, and hornblende. Though stained or dulled in appearance, the material is only slightly weathered. It was certainly derived by rapid and forceful erosion and swiftly carried to its present position, and the suggestion has been made that it is glacial outwash. The coarsest material consists of cobbles a foot or more in diameter. The bulk of the material is gravel and coarse sand, and the present correlation includes in the unit some layers of silt and clay. The thickness is extremely variable, being about 50 feet over much of the area, although it thickens to 150 feet where it fills the buried valley and, as mentioned above it is absent in one small area. The elevation of the upper surface ranges from about 100 to 200 feet below sea level. There is some suggestion that this surface slopes to the south, which is probably the original angle of deposition as the formation must now lie in very nearly the attitude in which it was deposited.

Veatch[19] believed that the gravel deposits which make up the Jameco were swept down from the north as outwash from a glacier which stood with its front near the present northern edge of Long Island, although there appears to be no reason why the ice front should not have been some tens of miles farther north. Veatch, who imagined the Sound River Valley connecting the Sound with the buried valleys to the south, believed that this valley formed a pathway for the outwash. It is just as easy to believe that the outwash was swept through the low pass in the ridge of Cretaceous deposits which lies in eastern Queens County, near the present site of Bayside, and also through low areas which may have lain to the west. This outwash then fanned out to the south and buried the older topography, including the valley segments which are discussed above. This interpretation indicates that the material now filling those valleys is Jameco, even though a large part of it is clay and fine sand. It is a little puzzling that the clay in the Jameco is found only in the valley fillings, while elsewhere the formation is composed of coarse sand and gravel. The fine-grained materials might have been deposited at times of low water and diminishing flow, and at these times such water as was moving would have been confined to whatever valleys were available. Once the valleys were filled, the sudden floods which characterize glacial streams would have fanned out and deposited the apron of coarse sands and gravel which make up the bulk of the unit. This picture of the origin of the formation agrees with what is known of the distribution of the Jameco, for it is found to the south of the ridge of Cretaceous sands and clays which form the backbone of the island only where this ridge is crossed by a relatively low pass, or where there was an apparent opportunity for material to have been swept around its end.

The Jameco gravel is recognized by its color and composition and by its position between the bedrock or the Cretaceous strata below and the Gardiners clay above. Its position with respect to sea level is also an aid to its identification. In the absence of the Gardiners clay, or in places where for one reason or another the Gardiners could not be identified, it would be difficult or impossible to distinguish the Jameco from the upper Pleistocene deposits in many well logs. In the case of the valley-fill deposits, only the plotting to scale of cross-sections, using a number of wells, gives any clue to the relationships. Lacking the data for such a group study, a single well log from the area of one of the buried valleys would not generally give, by itself, enough evidence for a correlation. In western Long Island, and in particular in southern Kings and Queens Counties, the Jameco contains a high proportion of grains and pebbles of dark, fine-grained igneous rock. This material is similar to, and apparently derived from, the Triassic diabase of the New Jersey Palisades, suggesting that the source of this part of the Jameco gravel was in large part in the valley of the Hudson River. To the east, in Nassau and Suffolk Counties, the Jameco contains less diabase and more granite, schist, and gneiss, so that its composition is similar to that of the upper Pleistocene deposits.

Gardiners clay. The Jameco gravel grades upward rather abruptly into the Gardiners clay. This has been confirmed in the one locality where the contact has been observed (Tunnel 2, shaft near well K 703), where Blank[20] found the contact to be conformable. Such fossils as have been found in the clay point to shallow-water marine deposition under slightly warmer conditions than prevail today. If, then, the Jameco gravel represents the outwash of a glacial advance, the Gardiners clay was formed during the following interglacial period.

The Gardiners clay underlies all of Kings County except for a narrow belt along the East River, in parts of which it probably never was deposited and from the rest of which it is believed to have been eroded. It is largely composed of dark clay, commonly referred to by the drillers as "blue clay". Locally it is described as slit or as a mixture of fine sand and clay. In places, also, though not in Kings, it contains lenses of coarse sand or gravel which are the source of limited ground-water withdrawals. The clay and fine sands contain a little biotite and other dark-colored mineral grains, and also a little woody material and shells. The shells are largely of gastropods and pelecypods and are commonly referred to by the drillers as oyster shells. Diatoms[21] have been found locally in the Gardiners, and this is perhaps the one formation on the island which shows promise of being traced by its fossil content as revealed in well samples . Unfortunately, the diatom flora of the Gardiners consists almost entirely of species living today at about the same latitude, so that there may be considerable difficulty in separating the Gardiners from more recent clays by use of this method.

[19] Op. cit., p. 34.

[20] Blank, H. R., "City Tunnel No. 2, Geology of Overburden"; unpublished notes and section in files of U. S. Geol. Survey.

[21] Lohman, K. E., Op. cit.

The Gardiners clay in Kings County is about 50 feet thick where it is typically developed. It appears to be thicker in a few wells, for example well K 894, but this may be due to poor logs or to faulty correlation. It is also thicker in a few wells, such as K 543, which are located along the line of one of the buried valley segments. In these cases it is believed that the Jameco gravel had not completely filled the valley and that the slight depression remaining was the cause of a thicker-than-normal accumulation of the Gardiners clay. The upper surface of the Gardiners clay in Kings County is believed everywhere to be at least 50 feet below sea level, on the assumption that sea level at the time of its deposition stood that much lower than it does at present. There has been little direct evidence to prove this, and this figure may well need to be revised so that still higher clays may be included in the formation. However, this assumption has served as a useful rule of thumb for the present work and has caused no obvious conflict with other data. In central and southern Kings the upper surface of the Gardiners clay lies 100 to 150 feet below sea level, and in a general way the formation seems to dip to the south. This dip is not the result of subsequent tilting but is due to the deposition of a fairly even thickness of clay on a surface which already had this slope.

Where the Gardiners clay is overlain by more recent clays the determination of its upper surface is not easy. Where there are enough neighboring wells to make possible a fairly detailed study of underground conditions, the assumption that the Gardiners is a relatively continuous blanket, whereas the younger clays are in smaller lenses, can be used to trace the contact. However, this method is undesirably arbitrary. This same line of reasoning lies back of the conclusion, reluctantly reached, not to classify as Gardiners any of the clays or fine sands lying northwest of a line marked by wells K 461, K 664, K 320, and K 703 (pl. 2). In the narrow belt along the East River so delineated, a number of wells, for example K 458, show clays which might well be Gardiners, but a comparison with adjacent logs shows that these patches of clay are not continuous. Because hydrologically the importance of the Gardiners lies in the relatively continuous seal which it provides for the underlying Jameco gravel, it was felt that little harm would be done by including isolated remnants of the Gardiners with hydrologically similar patches of younger clay. The alternative would be a classification which would suggest that the blanket of Gardiners extends unbroken into an area where no such impermeable layer in fact still exists. This would be unfortunate, and the plan used, which avoids doing this, involves no deliberate misrepresentation. In the area involved, accurate correlation in any case is quite impossible, and of the several equally valid geologic interpretations it seemed wise to follow the one which gives the most readily usable hydrologic picture.

Jacob sand (not recognized in Kings County logs). The Gardiners clay grades upward into the Jacob sand in northern, central, and eastern Long Island, where a few small scattered exposures reveal something of the nature of this part of the geologic column. The Jacob sand probably extends to the south and west of the areas where it has been observed and may be present in Kings County. It has been described as a fine-grained, well-bedded, light-colored sand, and so differs in no way which can be determined in the average well log from some of the outwash in the overlying upper Pleistocene deposits. In origin it is most nearly related to the Gardiners clay and it represents a change from the deposition of the clay of that period, brought on by the first distant accumulations of ice which were later to culminate in the next glacial advance over Long Island. Partly for this reason, and partly because the Gardiners clay itself is locally reported as fine sand, such as at well K 521, there was a tendency to include fine sands near the top of the Gardiners with that unit, as in K 64 (No. 2), rather than with the upper Pleistocene deposits, though no fixed policy was possible. Hydrologically the inclusion of the Jacob with the Gardiners is probably wise, as these fine sands might be expected to act more as a barrier to the movement of water than as a ground-water conduit or reservoir. Actually the Jacob could not be recognized with assurance in any of the Kings County logs, and the correlations were necessarily carried out as though it was not present in the area.

Upper Pleistocene deposits. The term "upper Pleistocene" is introduced here for the first time in Long Island geology with the hope that it will supplant the unfortunate term "post-Jameco", of which it is essentially the equivalent. The material to which this name is applied forms a hydrologic but not a geologic unit. Included in it are all the deposits which overlie the Jacob sand and the Gardiners clay, with the exception of the material of Recent age. It comprises the Manhasset formation[22], which is believed to be of Illinoian or Wisconsin age, and also the later till, moraine, and outwash which are held by most workers to be of Wisconsin age. A proper geologic name for this hydrologic unit is difficult to devise, since more than one formation is included, and their ages are uncertain. It seems definite, however, that all the material was deposited in the later half at least of the Pleistocene and so the term "upper Pleistocene" does not seem to stand in danger of being compromised by more exact determinations of the ages of the glacial deposits.

The constituent materials of the upper Pleistocene deposits in Kings County show considerable variation. In the south there is 150 feet or so of fine sand, with some clay layers near the top and coarser material near the bottom, as at well K 464. In the Coney Island area a number of wells, for instance well K 1020, show a clay or fine sand layer about 60 to 80 feet below sea level. This layer resembles at least superficially the Gardiners clay, but the log of well K 1 indicates strongly that this layer is part of the upper Pleistocene deposits and that the Gardiners is here

[22]Fuller, Op. cit., p. 114.

about 150 feet below sea level. In central Kings the upper Pleistocene deposits have thickness of more than 200 feet and the material generally is coarser, though clay beds are present locally, as at well K 517. In most of the northwestern half of the county, many of the logs show beds of clay and boulders, or sand, clay, and boulders, as at well K 893, suggesting that considerable till is present. In a few of the wells, such as K 956, there is even a suggestion of two or more tills, as might be expected if the Manhasset formation with its Montauk till member, and also the younger Ronkonkoma and Harbor Hill moraines, are all present in the area. Well records, however, do not provide the information necessary for the identification and correlation of such deposits and this was not attempted. H. R. Blank in 1934 had the opportunity of observing exposures of some of this material in place in the shafts which were sunk during the construction of City Tunnel 2. His unpublished notes[23] show that he saw as many as three, more or less distinct tills in what is here called the upper Pleistocene deposits, but even under these excellent conditions of observation he was unable to determine to which of the several local periods of glaciation they belonged and felt it best to give several alternate correlations.

The difficulty of subdividing the upper Pleistocene deposits and of relating the history and deposits of one area to those in another offers a scientific challenge, but raises no serious problem for the present study. Hydrologically the upper Pleistocene deposits are a unit, even though not a very uniform one. The coarse sands and gravels which are found in greater or lesser quantities in all parts of this unit are the source of most of the ground-water withdrawals in Kings County and in the remainder of Long Island. The yield of water and the position and thickness of the most suitable aquifer differ greatly. This is due, however, more to local conditions than it is to the regional picture. Such silt and clay beds as are present are limited in extent, and although they may restrict recharge in some areas and in other ways divert or limit the movement of ground water, these effects are not of regional importance.

Recent deposits. The deposits of Recent age in Kings County are the beach sands along the coast, and the clays and silts of Jamaica Bay and the East River. The beach sands are of little importance, but the clay serves to seal the glacial gravels and other permeable beds from the salt water. It is not practical, however, to separate the Recent clays from those of Pleistocene age and no attempt was made in this study to separate them.

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[23]Op. cit.

TENTATIVE GEOLOGIC CORRELATIONS OF WELL LOGS IN KINGS COUNTY, LONG ISLAND, N. Y.

NOTES

Caution: The reader must keep in mind that all the figures shown indicate **feet above or below sea level,** unlike the well logs from which they are derived, where all measurements are made down from some point at or near the land surface. Elevation of land surface at well is first figure in column "Recent and upper Pleistocene."

Wells Included: In general, a correlation has been attempted for every well log published in Bulletins GW-3 and GW-8, "Record of Wells in Kings County, N. Y.", published jointly by the State Water Power and Control Commission and the U. S. Geological Survey. A few of these wells have been omitted because the records were unsatisfactory. Also included are a few deep wells from U. S. Geological Survey Professional Paper 44. (Veatch.)

Map Coordinates: The coordinates indicate the 1,000-yard square in which the well is located. These squares are the same as those printed on the Army Map Service 1:25,000 sheets for this area, although the method of designation has been changed in the case of the two maps accompanying these tables. When the coordinates are followed by an asterisk (*), that well number does not appear on the first map, as where there is more than one well at the same location, only the number of the deepest well is shown. The second map shows only wells which penetrate material deeper than the upper Pleistocene deposits.

Total Depth: The total depth, in feet, shown is calculated from the land surface, regardless of the measuring point used for the published log. The bottom is taken as the lowest point described in the well log, and this figure is in boldface in the tables. In a few cases the screen is set deeper than this but no record is available of the material penetrated.

Recent and Upper Pleistocene Deposits: This column includes all that material which is younger than the Gardiners clay, measured downward from the land surface to the top of the Gardiners, the surface of the bedrock, or, in a few cases, the top of the Cretaceous beds.

Reliability of Correlation: The tables are based on the assumption that the driller in each case has accurately reported the nature and depth of the beds penetrated. The "good", "fair", or "poor" notation under the headings or "reliability" indicates the confidence of the writer in his interpretation of the record. For a description of the geologic units and a discussion of the geology and hydrology of the area, the reader is referred to the accompanying text.

Well Number	Map Coordinates	Remarks	Total Depth	Recent and Upper Pleistocene Deposits	Gardiners Clay	Jameco Gravel	Magothy (?) Formation	Raritan Formation		Bedrock		Reliability of Correlation	Screen Setting	Aquifer Developed[1]	Well Number
								Clay Member	Lloyd Sand Member	Weathered	Fresh				
K 1	F 2	No record −575 to −673. Bedrock may be at −625.	750	+ 5 −150	−150 −163	−163 −229	−229 −393	−393 −471	−471 −575	(No record −575 to −673)	at **−673**	Fair	−477 −519	L	K 1
K 8	F 11		197	+169 **− 28**								Good	?		K 8
K 9	E 13		149	+ 4 − 91	− 91 −125	−125 −145					at **−145**	Good	−125 −145	J	K 9
K 10	F 14	No log; sample suggests J from −128 to −152	161	+ 9 ?	? −128	−128 **−152**						Poor	Probably −128 to −152	Probably J	K 10
K 12	F 16	No log. Only record is Br. at −50	112	+ 49 ?							− 50 **− 63**	——	?		K 12
K 14	F 17		95	+ 29 **− 66**								Good	− 48 − 68	UP	K 14
K 15	G 16	Clay −93 to −99. May be G	114	+ 15 − 93						− 93 **− 99**		Fair	− 67 − 92	UP	K 15
K 18	G 15	No record +48 to 0	114	+ 48 **− 66**								Good	− 45 − 65	UP	K 18
K 19	G 14	No log; hydrologic data suggests Jameco gravel at −97										Fair	− 97 ?	J	K 19
K 20	H 14		148	+ 52 − 94	− 94 **− 96**							Fair	?		K 20
K 22	H 14		139	+ 74 **− 65**								Good	− 22 − 63	UP	K 22
K 23	H 14	Log only to −95	?	+ 73 − 95	?	?					at **−170**	Fair	− 59 − 93	UP	K 23
K 33	I 16		176	+ 14 −102	−102 −131	−131 **−162**						Good	− 61 to − 80 −138 to −161	UP and J	K 33
K 36	K 16		108	+ 28 − 77	− 77 **− 80**							Good	− 45 − 75	UP	K 36
K 37	K 17		130	+ 25 − 92	− 92 **−105**							Good	? − 79	UP	K 37
K 40	L 13		136	+100 **− 36**								Good	− 16 − 36	UP	K 40
K 43	M 12		165	+ 55 **−110**								Good	− 80 −110	UP	K 43
K 45	N 14		177	+105 **− 72**								Good	− 50 − 64	UP	K 45
K 49	I 19		333	+ 18 −114							−114 **−315**	Fair	? −193	Br	K 49
K 50	I 19		169	+ 28 **−141**							at **−141**	Fair	− 4 − 24	UP	K 50

[1]UP—Upper Pleistocene
G—Gardiners clay
J—Jameco gravel
M—Magothy (?) formation
L—Lloyd sand
Br—Bedrock

TENTATIVE GEOLOGIC CORRELATIONS OF WELL LOGS
IN KINGS COUNTY, LONG ISLAND, N. Y.

Well Number	Map Coordinates	Remarks	Total Depth	Recent and Upper Pleistocene Deposits	Gardiners Clay	Jameco Gravel	Magothy (?) Formation	Raritan Formation: Clay Member	Raritan Formation: Lloyd Sand Member	Bedrock: Weathered	Bedrock: Fresh	Reliability of Correlation	Screen Setting	Aquifer Developed[1]	Well Number
K 59	L 17		76	+ 17 — 59								Good	— 48 — 58	UG	K 59
K 64 #2	J 16*	K 1275, deeper, same location	168	+ 10 — 65	— 65 —110	—110 —158						Good	?		K 64 #2
K 64 #5	J 16*	K 1275, deeper, same location	165	+ 10 — 58	— 58 —125	—125 —155						Good	?		K 64 #5
K 64 #6	J 16*	K 1275, deeper, same location	174	+ 10 — 67	— 67 —130	—130 —164						Good	?		K 64 #6
K 64 #7	J 16*	K 1275, deeper, same location	165	+ 10 — 68	— 68 —122	—122 —153						Good	?		K 64 #7
K 80	H 16*	K 1018, deeper, same location	101	+ 30 — 71								Good	— 56 — 71	UP	K 80
K 82	H 16	No record —44 to —100	120	+ 20 — 44	?						at —100	——	? —100	UP	K 82
K 89	L 15		122	+ 55 — 67								Good	— 40 — 50	UP	K 89
K 90	L 15		101	+ 51 — 50								Good	— 30 — 50	UP	K 90
K 96	I 15		74	+ 57 — 17								Good	?		K 96
K 110	F 16	Same location — K 881 No record —64 to —88	160	+ 72 — 88							at — 88	Fair	— 40 — 63	UP	K 110
K 117	F 15	K 1251, shallower, same location	108	+ 45 — 63								Good	— 37 — 62	UP	K 117
K 118	G 15		100	+ 37 — 63								Good	— 43 —63	UP	K 118
K 131	J 14	No record —98 to —258	312	+ 54 — 98									— 61 —93	UP	K 131
K 139	Q 15		106	+ 55 — 51								Good	— 31 — 51	UP	K 139
K 155	G 12		202	+150 — 52								Good	— 37 — 52	UP	K 155
K 165	D 11		93	+ 15 — 78								Good	— 55 — 73	UP	K 165
K 167	D 11		150	+ 13 — 73	— 73 — 82	— 82 —137						Good	—117 —137	J	K 167
K 174	H 5		110	+ 25 — 85								Good	— 70 ? — 85	UP	K 174
K 178	F 1		118	+ 5 —113								Good	—108 —123 ?	UP	K 178
K 182	K 17	K 1130, shallower, same location	94	+ 20 — 74								Good	?	UP	K 182
K 191	N 12*	K 1134, deeper, same location	68	+ 36 — 32								Good	?	UP	K 191
K 201	K 6*	K 1090, deeper, same location	83	+ 17 — 66								Good	— 51 — 66	UP	K 201

Please see the notes on the first page of the tables.

TENTATIVE GEOLOGIC CORRELATIONS OF WELL LOGS IN KINGS COUNTY, LONG ISLAND, N. Y.

Well Number	Map Coordinates	Remarks	Total Depth	Recent and Upper Pleistocene Deposits	Gardiners Clay	Jameco Gravel	Magothy (?) Formation	Raritan Formation: Clay Member	Raritan Formation: Lloyd Sand Member	Bedrock: Weathered	Bedrock: Fresh	Reliability of Correlation	Screen Setting	Aquifer Developed[1]	Well Number
K 210	I 2		150	+ 10 −140								Good	−114 −136	UP	K 210
K 211	H 1		118	+ 5 −113								Good	−103 −113	UP	K 211
K 229	H 1		118	+ 5 −113								Good	− 98 −113	UP	K 229
K 244	D 8		134	+ 67 − 67								Good	− 34 − 50	UP	K 244
K 245	E 9		178	+130 − 48								Good	− 27 − 43	UP	K 245
K 249	J 15		105	+ 40 − 65								Good	− 50 − 65	UP	K 249
K 251	D 10		177	+110 − 67								Good	− 43 − 63	UP	K 251
K 252	F 13		131	+ 63 − 68								Good	?	UP	K 252
K 254	L 15	K 900, shallower, same location	100	+ 53 − 47								Good	?	UP	K 254
K 255	K 16	K 952, shallower, same location	123	+ 54 − 69								Good	− 49 − 69	UP	K 255
K 256	I 15		112	+ 50 − 62								Good	− 40 − 56	UP	K 256
K 259	G 15	Bottom may touch Gard. clay	113	+ 40 − 73	(at −73?)							Fair	?	UP	K 259
K 260	G 15		109	+ 40 − 69								Good	− 48 − 68	UP	K 260
K 261	F 15	K 1061, shallower, same location	110	+ 50 − 59							− 59 − 60	Good	− 39 − 59	UP	K 261
K 269	K 15		116	+ 60 − 56								Good	− 38 − 52	UP	K 269
K 271	F 16		122	+ 76 − 46								Good	− 28 − 41	UP	K 271
K 272	G 15*	K 1073, deeper, same location	89	+ 34 − 55								Good	− 27 − 47	UP	K 272
K 276	F 15	K 935, shallower, same location	117	+ 45 − 72								Good	− 44 − 69	UP	K276
K 277	G 15		146	+ 37 − 97	− 97 −109						at −109	Fair	?	UP	K 277
K 283	G 1		154	+ 7 −147								Fair	−107 −142	UP	K 283
K 284	C 8		167	+ 75 − 92								Good	− 63 − 89	UP	K 284
K 285	E 8	No record +8 to −64 Probably all UP	127	+ 63 + 8								Fair	− 38 − 64	UP	K 285
K 290	G 15		110	+ 45 − 64	− 64 − 65						at − 65	Fair	− 38 − 64	UP	K 290

Please see the notes on the first page of the tables.

TENTATIVE GEOLOGIC CORRELATIONS OF WELL LOGS IN KINGS COUNTY, LONG ISLAND, N. Y.

Well Number	Map Coordinates	Remarks	Total Depth	Recent and Upper Pleistocene Deposits	Gardiners Clay	Jameco Gravel	Magothy (?) Formation	Raritan Formation: Clay Member	Raritan Formation: Lloyd Sand Member	Bedrock: Weathered	Bedrock: Fresh	Reliability of Correlation	Screen Setting	Aquifer Developed[1]	Well Number
K 296	F 9	K 1205, shallower, same location	119	+ 69 — 50								Good	— 30 — 50	UP	K 296
K 298	I 10		88	+ 50 — 38								Good	— 29 — 38	UP	K 298
K 299	N 15	K 1040, shallower, same location	132	+ 69 — 63								Good	— 38 — 63	UP	K 299
K 300	K 9	K 1207, shallower, same location	71	+ 30 — 41								Good	— 28 — 40	UP	K 300
K 303	L 9	K 1209, same location, same depth	118	+ 14 —104								Good	— 50 — 90	UP	K 303
K 304	K 7		109	+ 15 — 94								Good	— 71 — 91	UP	K 304
K 305	H 4		87	+ 17 — 70								Good	— 50 — 70	UP	K305
K 308	D 8	K 1211, shallower, same location	146	+ 76 — 70								Good	— 44 — 70	UP	K 308
K 309	F 15	K 942, shallower, same location	110	+ 53 — 57								Good	— 37 — 57	UP	K 309
K 310	E 4		88	+ 27 — 61								Good	— 49 — 60	UP	K 310
K 311	F 7	Log starts 15 feet below land surface. See G-W8	96	+ 43 — 53								Good	— 33 — 53	UP	K 311
K 316	C 8*	K 1041, deeper, same location	124	+ 65 — 59								Good	— 50 — 55	UP	K 316
K 318	F 1		135	+ 7 —128								Good	—108 —128	UP	K 318
K 319	C 7		162	+ 80 — 82								Good	?	UP	K 319
K 320	G 15		114	+ 38 — 63	— 63 — 75						— 75 — 76	Good	?	UP	K 320
K 323	I 12		139	+ 85 — 54								Good	— 36 — 46	UP	K 323
K 326	J 16	K 1214, shallower, same location	108	+ 26 — 82								Good	— 66 — 82	UP	K 326
K 328	E 5		112	+ 30 — 82								Good	— 57 — 74	UP	K 328
K 331	I 17		110	+ 40 — 70								Good	— 54 — 70	UP	K 331
K 332	L 12		112	+ 42 — 70								Good	— 50 — 70	UP	K 332
K 335	M 13		104	+ 45 — 59								Good	— 44 — 59	UP	K 335
K 336	I 6		118	+ 26 — 92								Good	— 77 — 92	UP	K 336
K 340	F 16		136	+ 66 — 72								Good	— 49 — 68	UP	K 340

Please see the notes on the first page of the tables.

TENTATIVE GEOLOGIC CORRELATIONS OF WELL LOGS IN KINGS COUNTY, LONG ISLAND, N. Y.

Well Number	Map Coordinates	Remarks	Total Depth	Recent and Upper Pleistocene Deposits	Gardiners Clay	Jameco Gravel	Magothy (?) Formation	Raritan Formation: Clay Member	Raritan Formation: Lloyd Sand Member	Bedrock: Weathered	Bedrock: Fresh	Reliability of Correlation	Screen Setting	Aquifer Developed[1]	Well Number
K 341	H 5		103	+ 22 — 81								Good	— 71 — 81	UP	K 341
K 345	F 14		146	+ 17 —129								Good	—109 —129	UP	K 345
K 426	J 17		140	+ 38 — 64	— 64 —102							Good	— 48 — 64	UP	K 426
K 457	D 15		57	+ 7 — 50								Good	— 28 — 48	UP	K 457
K 458	H 18		178	+ 5 —173							at —173	Poor	——	——	K 458
K 459	H 14*	K 873, deeper well, at same location	140	+ 75 — 65								Fair	— 38 — 53	UP	K 459
K 461	J 19	K 679, shallower, same location	225	+ 33 —172				—172 —192		?	at —192	——	?		K 461
K 464	M 6		494	+ 5 —159	—159 —202	—202 —245	—245 —284	—284 —443	—443 —489			Fair	?	L	K 464
K 465	I 21	Only record is Br at —55	181 or 400	+ 10 ?							at — 55	——	?		K 465
K 501	G 9*	K 525 deeper, same location	112	+ 47 — 65								Good	— 15 — 55	UP	K 501
K 502	J 9		106	+ 11 — 95								Good	— 42 — 90	UP	K 502
K 503	G 10*	K 529, deeper, same location	137	+ 63 — 74								Good	— 34 — 74	UP	K 503
K 504	K 9*	K 515, deeper, same location	108	+ 20 — 88								Good	— 45 — 88	UP	K 504
K 505	J 9		91	+ 16 — 75								Good	— 32 — 76	UP	K 505
K 506	K 11*	K 524, deeper, same location	113	+ 33 — 80								Good	— 19 — 62	UP	K 506
K 507	K 11*	K 519, deeper, same location	100	+ 31 — 69								Good	— 19 — 62	UP	K 507
K 508	G 10		116	+ 50 — 66								Good	— 22 — 64	UP	K 508
K 509	J 9*	K 515, deeper same location	97	+ 20 — 77								Good	— 33 — 77	UP	K 509
K 510	F 9		120	+ 63 — 57								Good	— 4 — 48	UP	K 510
K 511	K 9*	K 518, deeper, same location	93	+ 12 — 81								Good	— 41 — 80	UP	K 511
K 512	H 10		106	+ 48 — 58								Good	— 10 — 53	UP	K 512
K 513	G 8		105	+ 53 — 52								Good	— 2 — 39	UP	K 513
K 514	L 9	From record by F. G. Wells	560	+ 26 —149	—149 —167	—167 —197	Probably not present	—197 —418	Probably not present	—418 —440	—440 —534	Fair	— 22 — 64	UP	K 514

Please see the notes on the first page of the tables.

TENTATIVE GEOLOGIC CORRELATIONS OF WELL LOGS IN KINGS COUNTY, LONG ISLAND, N. Y.

Well Number	Map Coordinates	Remarks	Total Depth	Recent and Upper Pleistocene Deposits	Gardiners Clay	Jameco Gravel	Magothy (?) Formation	Raritan Formation: Clay Member	Raritan Formation: Lloyd Sand Member	Bedrock: Weathered	Bedrock: Fresh	Reliability of Correlation	Screen Setting	Aquifer Developed[1]	Well Number
K 515	J 9	K 507, K 509, shallower, same location	343	+ 20 −146	−146 −180	−180 −323		at **−323**				Fair	−186 to −196 −282 to −321	J	K 515
K 516	L 12*	K 533, deeper, same location	106	+ 42 **− 64**								Good	− 16 − 59	UP	K 516
K 517	I 12		303	+ 78 −110	−110 −165	−165 −220	−220 **−225**					Poor	−169 −212	J	K 517
K 518	K 9	K 511, shallower, same location	330	+ 13 −157	−157 −184	−184 **−317**						Fair	−287 −302	J	K 518
K 519	K 11	K 507, shallower, same location	250	+ 29 −131	−131 −157	−157 −219	−219 **−221**					Poor	−166 −209	J	K 519
K 520	L 12*	K 533, deeper, same location	310	+ 42 − 98	− 98 −168	−168 **−268**						Fair	−211 −253	J	K 520
K 521	L 10		430	+ 34 −136	−136 −179	−179 −223		−223 −323	−323 **−376**			Fair	−336 −384	L	K 521
K 522	I 10	K 527, shallower, same location	300	+ 50 − 91	− 91 −131	−131 −240		−240 **−250**				Fair	−144 to −194 −223 to −243	J	K 522
K 523	H 8	Br. data vague	535	+ 47 −123	−123 −153	−153 −303	−303 −384			−384 ? **−488**	?	Fair	−155 −221	J	K 523
K 524	K 11	K 506, shallower, same location	390	+ 33 −176	−176 −198	−198 −254	Probably missing	−254 −336	−336 −349	?	−349 **−357**	Fair	−193 −253	J	K 524
K 525	G 9	K 501, shallower, same location	400	+ 47 −173	−173 −217	−217 −329	−329 **−353**					Poor	−213 −253	J	K 525
K 526	I 12	Record used is composite of K 526 (to −146) and K 531	378	+ 82 −146	−146 −208	−208 −256	−256 −288	Missing	Missing	−288 −291	−291 **−296**	Fair	−208 −276	J	K 526
K 527	I 10*	K 522, deeper, same location	145	+ 49 **− 96**								Good	− 34 − 85	UP	K 527
K 528	J 11	K 1352, shallower, same location	360	+ 61 −159	−159 −195	−195 −237	Probably absent	−237 −298	Probably absent	?	−298 **−299**	Fair	−192 −242	J	K 528
K 529	G 10	K 503, shallower, same location	220	+ 62 −151	−151 **−158**							Fair	− 38 − 83	UP	K 529
K 530	H 9		160	+ 33 −112	−112 **−127**							Fair	− 62 −112	UP	K 530
K 531	I 12	See composite record with K 526 above													K 531
K 532	J 9		470	+ 16 −146	−146 −178	−178 −312	Probably absent	−313 −409	Probably absent	−409 **−454**		Fair	−294 −309	J	K 532
K 533	L 12	K 516, K 520, shallower, same location	395	+ 42 − 98	− 98 −168 See K 520	−168 −268	−268 −348	Probably absent	Probably absent	?	−348 **−353**	Fair	−238 −248	J	K 533
K 534	J 9		469	+ 17 −150	−150 ?	? −302	May be absent	−302 −404	Probably absent	−404 −416	−416 **−452**	Poor	−283 −295	J	K 534
K 537	M 10	From Crosby's record	213	+ 19 −128	−128 −164	−164 **−194**						Poor	?		K 537
K 538	Q 13	K 1139, shallower, same location	172	+ 10 − 60	− 60 −112	−112 **−162**						Fair	?		K 538
K 541	D 7		120	+ 90 **− 30**								Good	?	UP	K 541

Please see the notes on the first page of the tables.

TENTATIVE GEOLOGIC CORRELATIONS OF WELL LOGS IN KINGS COUNTY, LONG ISLAND, N. Y.

Well Number	Map Coordinates	Remarks	Total Depth	Recent and Upper Pleistocene Deposits	Gardiners Clay	Jameco Gravel	Magothy (?) Formation	Raritan Formation: Clay Member	Raritan Formation: Lloyd Sand Member	Bedrock: Weathered	Bedrock: Fresh	Reliability of Correlation	Screen Setting	Aquifer Developed[1]	Well Number
K 543	P 14	From Crosby's record	284	+ 63 —129	—129 —218	—218 —221						Fair	?		K 543
K 550	E 1		110	+ 5 —105								Good	+ 83 —103	UP	K 550
K 569	K 18	(Veatch No. 65)	190	+ 15 ?	? —175	at —175						Poor	?		K 569
K 575	H 5		106	+ 24 — 82								Good	— 68 — 82	UP	K 575
K 576	B 6		123	+ 82 — 41								Good	— 21 — 37	UP	K 576
K 577	L 5		100	+ 12 — 88								Good	— 80 — 88	UP	K 577
K 578	M 12		92	+ 44 — 48								Good	— 37 — 48	UP	K 578
K 579	J 20		825	+ 7 — 75							— 75 —818	Good	?		K 579
K 580	K 6		69	+ 18 — 51								Good	— 39 ? — 51	UP	K 580
K 584	C 8		145	+ 60 — 70	— 70 — 85							Fair	?		K 584
K 594	H 16		91	+ 30 — 61								Good	— 51 — 59	UP	K 594
K 615	J 14		140	+ 80 — 60								Good	— 45 — 60	UP	K 615
K 619	N 12		451	+ 25 —101	—101 —120	—120 —206	Probably absent	—206 —403	—403 —426	?	at —426	Fair	?	L	K 619
K 620	N 13		96	+ 44 — 52								Good	— 31 — 51	UP	K 620
K 624	P 14		85	+ 45 — 40								Good	— 19 — 39	UP	K 624
K 627	G 9		116	+ 65 — 51								Good	— 31 — 51	UP	K 627
K 630	F 6		105	+ 25 — 80								Good	— 57 — 82	UP	K 630
K 634	Q 14		100	+ 20 — 80								Good	— 65 — 80	UP	K 634
K 635	E 6		75	+ 20 — 55								Good	— 43 — 55	UP	K 635
K 636	D 7		98	+ 50 — 46								Good	?	UP	K 636
K 637	J 17	Correlation from log in GW-8	221	+ 44 — 55	— 55 —114	—114 —168	Absent	Absent	Absent	?	—168 —177	UP & G Fair J Poor	— 32 — 54	UP	K 637
K 638	F 13	See log GW-8. K 1332 shallower, same location	175	+ 9 —135	—135 —136	—136 —166	Absent	Absent	Absent	?	at —166	Good	—151 —166	J	K 638
K 639	F 13	K 1010, same location, shallower	190	+ 28 —122	—122 —142	—142 —162						Good	None		K 639

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TENTATIVE GEOLOGIC CORRELATIONS OF WELL LOGS IN KINGS COUNTY, LONG ISLAND, N. Y.

Well Number	Map Coordinates	Remarks	Total Depth	Recent and Upper Pleistocene Deposits	Gardiners Clay	Jameco Gravel	Magothy (?) Formation	Raritan Formation: Clay Member	Raritan Formation: Lloyd Sand Member	Bedrock: Weathered	Bedrock: Fresh	Reliability of Correlation	Screen Setting	Aquifer Developed[1]	Well Number
K 640 #5	E 16	Only record is elev. of Br.									at — 71		?		K 640 #5
K 641	E 17	Only record is elev. of Br.									at — 64		?		K 641
K 642 #2	E 17	Only record is elev. of Br.									at — 91		?		K 642 #2
K 643	J 7		142	+ 15 —127								Fair	None		K 643
K 644	G 6		153	+ 25 —128								Fair	None		K 644
K 645	F 13		96	+ 15 — 81								Good	Probably None		K 645
K 646	F 13	From Crosby record.	194	+ 10 — 97	— 97 —144	—144 —184						Good	Probably None		K 646
K 648	F 13		197	+ 38 —112	—112 —114	—114 —159						Good	None		K 648
K 650	F 13	K 1245, shallower, same location.	195	+ 10 —111	—111 —167	—167 —185						Good	None		K 650
K 651	F 13		165	+ 15 ?	? —135	—135 —150						Poor	None		K 651
K 652	F 13		200	+ 10 —133	—133 ?	? —190						Poor	None		K 652
K 654	F 14		158	+ 25 —100							—100 —133	Good	None		K 654
K 655	G 15		214	+ 43 —147						—147 —156	—156 —175	Fair	None		K 655
K 656	G 15	Shaft 16A same location.	159	+ 43 — 89							— 89 —116	Good	None		K 656
K 657	G 14	Log unreliable except for data on Br.	228	+ 44 ?	?	?					—162 —184		None		K 657
K 658	H 15		202	+ 61 —103	—103 —120						—120 —141	Fair	None		K 658
K 659	G 15		170	+ 38 —106							—106 —132	Poor	None		K 659
K 660	G 15		125	+ 35 — 67							— 67 — 90	Fair	None		K 660
K 661	G 15	Shaft 15A, better log, used. Same location.	147	+ 62 — 66	— 66 — 70						— 70 — 85	Good	None		K 661
K 662	F 17		108	0 (River) — 98							— 98 —108	Fair	None		K 662
K 663	H 16	No record —151 to —161.	195	+ 14 —101	—101 —121	—121 —151?				—151 ? —161	—161 —181	Fair	None		K 663
K 664	H 17		179	+ 17 —104	—104 —142						—142 —162	Fair	None		K 664
K 665	H 16		170	+ 12 —108	—108 —140						—140 —158	Fair	None		K 665

Please see the notes on the first page of the tables.

TENTATIVE GEOLOGIC CORRELATIONS OF WELL LOGS IN KINGS COUNTY, LONG ISLAND, N. Y.

Well Number	Map Coordinates	Remarks	Total Depth	Recent and Upper Pleistocene Deposits	Gardiners Clay	Jameco Gravel	Magothy (?) Formation	Raritan Formation		Bedrock		Reliability of Correlation	Screen Setting	Aquifer Developed[1]	Well Number
								Clay Member	Lloyd Sand Member	Weathered	Fresh				
K 666	I 17	Record unsatisfactory. G and J may be present.	214	+ 55 −139							−139 −159	Poor	None		K 666
K 667	I 17	Record unsatisfactory. G and J may be present.	201	+ 45 −143							−143 −156	Poor	None		K 667
K 668	E 14		200	+ 57 −123							−123 −143	Fair	None		K 668
K 669	E 14		182	+ 48 −114							−114 −134	Fair	None		K 669
K 670	I 17	Use record Shaft 14A. Same location.	120	+ 8 − 70			Absent	− 70 − 74	Absent	− 74 −100	−100 −112	Good	None		K 670
K 671	F 17		135	+ 37 − 76							− 76 − 98	Fair	None		K 671
K 672	I 18		170	+ 20 − 74	Absent	Absent	Absent	− 74 −130			−130 −150	Poor	None		K 672
K 673	J 18		195	+ 14 − 98	Absent	Absent	Absent	− 98 −161	Absent		−161 −181	Poor	None		K 673
K 674 #5	H 17	Other borings, same location, very similar.	97	+ 12 − 85							at − 85	Fair	None		K674 #5
K 675	K 18		222	+ 13 −148	−148 −190						−190 −209	Fair	None		K 675
K 676	F 15		163	+ 28 −127							−127 −135	Fair	None		K 676
K 677	K 18		215	+ 19 −107	Absent	Absent	Absent	−107 −176	Absent		−176 −196	Poor	None		K 677
K 678	J 18		221	+ 39 − 63	Absent	Absent	Absent	− 63 −160	Absent	−160 −162	−162 −182	Poor	None		K 678
K 679	J 19*	K 461, deeper, same location.	218	+ 35 − 85	Absent	Absent	Absent	− 85 −163	Absent		−163 −183	Poor	None		K 679
K 680	Q 12		434	+ 5 −105	−105 −151	−151 −211	−211 −284	−284 −408	−408 −429			Fair	Probably None		K 680
K 682	I 20		53	+ 10 − 43							at − 43	Good	None		K 682
K 684	F 17		104	+ 5 − 98							− 98 − 99	Good	None		K 684
K 685	F 17		91	+ 7 − 73							+ 73 − 84	Good	None		K 685
K 686	H 18		146	0 −146							at −146	Poor	None		K 686
K 687	I 17		200	+ 46 −128						−128 −129	−129 −154	Good	None		K 687
K 688	H 19		111	0 (River) −107							−107 −111	Good	None		K 688
K 689	K 19	Shaft 13A same location.	160	+ 31 −109						−109 −111	−111 −129	Good	None		K 689
K 690	J 19		194	+ 12 −161						−161 −162	−162 −182	Fair	None		K 690

Please see the notes on the first page of the tables.

TENTATIVE GEOLOGIC CORRELATIONS OF WELL LOGS IN KINGS COUNTY, LONG ISLAND, N. Y.

Well Number	Map Coordinates	Remarks	Total Depth	Recent and Upper Pleistocene Deposits	Gardiners Clay	Jameco Gravel	Magothy (?) Formation	Raritan Formation: Clay Member	Raritan Formation: Lloyd Sand Member	Bedrock: Weathered	Bedrock: Fresh	Reliability of Correlation	Screen Setting	Aquifer Developed[1]	Well Number
K 691	J 18		186	+ 20 −121						−121 −147	−147 −166	Fair	None		K 691
K 692	J 20		85	+ 3 − 82							at − 82	Good	None		K 692
K 693	B 6	No record −32 to −43.	105	+ 62 − 43								Fair	None		K 693
K 694	F 15		106	+ 16 − 87							− 87 − 90	Good	None		K 694
K 695	C 10		41	0 (River) − 41								Good	None		K 695
K 696	G 12		103	+140 + 37								Good	None		K 696
K 697	H 14		95	+143 + 48								Good	None		K 697
K 698	D 12		100	0 (River) −100								Fair	None		K 698
K 699	C 8		141	+ 55 − 82	− 82 − 86							Fair	None		K 699
K 700	E 13		127	+ 6 −110						−110 −121	at −121	Fair	None		K 700
K 701	D 12		83	0 (River) − 83								Good	None		K 701
K 702	F 14		136	+ 31 − 85							− 85 −105	Good	None		K 702
K 703	E 14	Use Record Shaft 17A same location.	138	+ 18 − 93	− 93 −104	−104 −110					−110 −120	Good	None		K 703
K 704	D 13		130	+ 7 −121						−121 −123		Fair	None		K 704
K 705	C 14		151	+ 10 −112						−112 −121	−121 −141	Fair	None		K 705
K 706	H 15		40	+ 86 + 46								Good	None		K 706
K 707	I 15		50	+ 56 + 6								Good	None		K 707
K 708	E 15		120	+ 6 − 82							− 82 −114	Good	None		K 708
K 709	F 16		139	+ 58 − 60							− 60 − 81	Good	None		K 709
K 710	I 20		54	+ 13 − 28						− 28 − 31	− 31 − 41	Good	None		K 710
K 711	K 20		74	0 (River) − 74							at − 74	Fair	None		K 711
K 712	B 7		69	+ 72 + 3								Fair	None		K 712
K 713	I 21		52	+ 6 − 46								Fair	None		K 713

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TENTATIVE GEOLOGIC CORRELATIONS OF WELL LOGS IN KINGS COUNTY, LONG ISLAND, N. Y.

Well Number	Map Coordinates	Remarks	Total Depth	Recent and Upper Pleistocene Deposits	Gardiners Clay	Jameco Gravel	Magothy (?) Formation	Raritan Formation: Clay Member	Raritan Formation: Lloyd Sand Member	Bedrock: Weathered	Bedrock: Fresh	Reliability of Correlation	Screen Setting	Aquifer Developed[1]	Well Number
K 714	E 13		100	0 (River) —100								Fair	None		K 714
K 715	J 17		120	+ 36 — 74	— 74 — 84							Fair	None		K 715
K 716	E 16		128	+ 67 — 61								Good	None		K 716
K 717	I 17		202	+ 45 —141							—141 —157	Poor	None		K 717
K 718	C 7	No record +39 to —296	435	+ 80 ?	?	?					—296 —345	Poor	None		K 718
K 719	E 10		89	+130 + 41								Good	None		K 719
K 720	E 13		103	+ 13 — 90								Fair	None		K 720
K 721	F 14		85	+ 18 — 67								Good	None		K 721
K 722	F 16		103	+ 60 — 43								Good	None		K 722
K 723	F 16		141	+ 57 — 72							— 72 — 84	Good	None		K 723
K 724	J 18		137	+ 48 — 73	— 73 — 89							Fair	None		K 724
K 725	F 14		115	+ 14 — 79							— 79 —101	Fair	None		K 725
K 726	D 11		45	+ 35 — 10								Good	None		K 726
K 727	E 11		29	+ 20 — 9								Good	None		K 727
K 728	F 16		132	+ 36 — 81							— 81 — 96	Good	None		K 728
K 729	G 16		175	+ 45 — 90	— 90 —108						—108 —130	Fair	None		K 729
K 730	G 15		134	+ 36 — 68							— 68 — 98	Good	None		K 730
K 731	F 15		210	+ 23 —160						—160 —167	—167 —187	Fair	None		K 731
K 873	H 14	K 459, shallower, same location	161	+ 78 — 88								Good	— 60 — 82	UP	K 873
K 879	H 15		147	+ 60 — 87								Good	— 76 — 87	UP	K 879
K 880	G 7		71	+ 30 — 41								Good	— 28 — 40	UP	K 880
K 881	F 16*	K 110, deeper, same location	141	+ 75 — 66								Good	— 40 — 65	UP	K 881
K 884	K 12		182	+120 — 62								Good	— 42 — 58	UP	K 884

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TENTATIVE GEOLOGIC CORRELATIONS OF WELL LOGS IN KINGS COUNTY, LONG ISLAND, N. Y.

Well Number	Map Coordinates	Remarks	Total Depth	Recent and Upper Pleistocene Deposits	Gardiners Clay	Jameco Gravel	Magothy (?) Formation	Raritan Formation: Clay Member	Raritan Formation: Lloyd Sand Member	Bedrock: Weathered	Bedrock: Fresh	Reliability of Correlation	Screen Setting	Aquifer Developed[1]	Well Number
K 886	I 20		89	+ 10 — 79								Good	?		K 886
K 887	K 16		127	+ 49 — 66	— 66 — 76							Fair	— 41 — 51	UP	K 887
K 888	K 8		51	+ 23 — 28								Good	— 19 — 28	UP	K 888
K 889	K 17		74	+ 15 — 59								Good	— 47 — 57	UP	K 889
K 890	D 9	K 1065, shallower, same location	177	+127 — 50								Good	— 33 — 50	UP	K 890
K 893	K 17		118	+ 20 — 61	— 61 — 98							Fair	— 45 — 61	UP	K 893
K 894	K 17		282	+ 30 — 57	— 57 —148	Probably Absent	Probably absent	—148 —252				Fair	— 42 — 57	UP	K 894
K 898	I 18		84	+ 7 — 77								Fair	— 36 — 49	UP	K 898
K 900	L 15*	K 254, deeper, same location	53	+ 53 0								Good	+ 28 + 2	UP	K 900
K 902	O 13		80	+ 50 — 30								Good	— 22 — 30	UP	K 902
K 907	F 12		130	+ 80 — 50								Good	— 25 — 47	UP	K 907
K 910	M 12		86	+ 45 — 41								Good	— 21 — 41	UP	K 910
K 912	F 15		83	+ 45 — 38								Good	— 26 — 38	UP	K 912
K 916	F 13*	K 920, deeper, same location	162	+ 13 —118	—118 —128	—128 —149						Fair	—137 —149	J	K 916
K 917	F 13		106	+ 10 — 96								Fair	— 80 — 96	UP	K 917
K 918	K 17		90	+ 17 — 73								Good	— 57 — 73	UP	K 918
K 919	J 10		73	+ 50 — 23								Good	— 13 — 23	UP	K 919
K 920	F 13	K 916, shallower, same location	164	+ 13 —117	—117 —122	—122 —151						Fair	—139 —151	J	K 920
K 921	H 14	Veatch No. 30	331	+118 ?	?	at — 99	?				at —218	Fair	at — 99	J	K 921
K 922	D 11		150	+ 12 — 87	— 87 —102	—102 —138						Good	—117 —138	J	K 922
K 923	F 9		121	+ 67 — 54								Good	— 37 — 53	UP	K 923
K 924	I 19		66	+ 20 — 46								Good	— 34 — 45	UP	K 924
K 925	M 12		94	+ 41 — 53								Good	— 41 — 53	UP	K 925

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TENTATIVE GEOLOGIC CORRELATIONS OF WELL LOGS IN KINGS COUNTY, LONG ISLAND, N. Y.

Well Number	Map Coordinates	Remarks	Total Depth	Recent and Upper Pleistocene Deposits	Gardiners Clay	Jameco Gravel	Magothy (?) Formation	Raritan Formation: Clay Member	Raritan Formation: Lloyd Sand Member	Bedrock: Weathered	Bedrock: Fresh	Reliability of Correlation	Screen Setting	Aquifer Developed[1]	Well Number
K 928	F 7		63	+ 43 — 20								Good	— 8 — 20	UP	K 928
K 930	F 14*	K 956, deeper, same location	180	+ 20 —123	—123 —129	—129 —160						Fair	—136 —160	J	K 930
K 931	F 14*	K 956, deeper, same location	110	+ 20 — 90								Good	— 78 — 90	UP	K 931
K 935	F 15*	K 276, deeper, same location	100	+ 45 — 55								Good	— 39 — 54	UP	K 935
K 937	G 15*	K 320, deeper, same location	90	+ 36 — 54								Good	— 21 — 54	UP	K 937
K 940	J 6		94	+ 12 — 72								Good	— 60 — 72	UP	K 940
K 942	F 15*	K 309, deeper, same location	75	+ 53 — 22								Good	— 5 — 22	UP	K 942
K 943	G 15		110	+ 39 — 76								Good	— 61 — 76	UP	K 943
K 946	K 9		70	+ 24 — 46								Good	— 34 — 46	UP	K 946
K 951	B 7		105	+ 75 — 30								Good	— 22 — 30	UP	K 951
K 952	K 16*	K 255, deeper, same location	122	+ 67 — 55								Good	— 38 — 55	UP	K 952
K 954	F 15		92	+ 40 — 52								Good	— 41 — 51	UP	K 954
K 955	K 17		80	+ 18 — 62								Fair	— 42 — 54	UP	K 955
K 956	F 14	K 930, K 931, shallower, same location	181	+ 22 — 96	— 96 —130	—130 —160						Good	—135 —160	J	K 956
K 957	I 9		62	+ 25 — 37								Good	— 19 — 26	UP	K 957
K 1010	F 13*	K 639, deeper, same location	181	+ 20 ?	? —136	—136 —161						Fair	—144 —160	J	K 1010
K 1012	D 11		181	+ 16 —100	—100 —124	—124 —165						Good	—132 —157	J	K 1012
K 1018	H 16	K 80, shallower, same location	116	+ 18 — 76	— 76 — 98							Fair	None		K 1018
K 1020	E 1		113	+ 5 —108								Fair	— 98 —108	UP	K 1020
K 1021	F 1		120	+ 10 —110								Fair	— 90 —110	UP	K 1021
K 1023	Q 14		97	+ 38 — 59								Good	— 42 — 58	UP	K 1023
K 1025	O 8	No log below 0, but screen set 0 to — 16	49	+ 5 — 44								Good	0 — 16	UP	K 1025
K 1026	J 8		92	+ 25 — 67								Good	— 51 — 67	UP	K 1026

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TENTATIVE GEOLOGIC CORRELATIONS OF WELL LOGS IN KINGS COUNTY, LONG ISLAND, N. Y.

Well Number	Map Coordinates	Remarks	Total Depth	Recent and Upper Pleistocene Deposits	Gardiners Clay	Jameco Gravel	Magothy (?) Formation	Raritan Formation: Clay Member	Raritan Formation: Lloyd Sand Member	Bedrock: Weathered	Bedrock: Fresh	Reliability of Correlation	Screen Setting	Aquifer Developed[1]	Well Number
K 1033	I 6		73	+ 25 — 48								Good	— 28 — 48	UP	K 1033
K 1035	O 13		150	+ 53 — 97								Good	— 71 — 97	UP	K 1035
K 1040	N 15*	K 299, deeper, same location	129	+ 70 — 59								Good	— 37 — 57	UP	K 1040
K 1041	C 8	K 316, shallower, same location	142	+ 65 — 77								Good	— 54 — 77	UP	K 1041
K 1042	F 12		198	+ 92 —106								Fair	— 86 —102	UP	K 1042
K 1046	K 11		94	+ 26 — 68								Good	— 52 — 68	UP	K 1046
K 1048	I 10	K 1049, shallower, same location	117	+ 38 — 79								Good	— 57 — 79	UP	K 1048
K 1049	I 10*	K 1048, deeper, same location.	89	+ 38 — 51								Good	— 20 — 51	UP	K 1049
K 1051	H 16		86	+ 20 — 66								Good	— 51 — 66	UP	K 1051
K 1054	Q 13		90	+ 26 — 63	— 63 — 64							Fair	— 42 — 62	UP	K 1054
K 1055	J 15		130	+ 53 — 77								Good	— 51 — 76	UP	K 1055
K 1056	O 2	Veatch 130; V 131, 132 similar.	740	+ 7 ?	? —123	—123 —213	—213 —493	—493 —683	—683 —733			Fair	?	L	K 1056
K 1060	M 10		77	+ 25 — 52								Good	— 40 — 52	UP	K 1060
K 1061	F 15*	K 261, deeper, same location.	102	+ 50 — 52								Good	— 31 — 51	UP	K 1061
K 1065	D 9*	K 890, deeper, same location.	172	+134 — 38								Good	— 14 — 38	UP	K 1065
K 1068	I 2		120	+ 10 —110								Good	— 90 —110	UP	K 1068
K 1069	E 13		61	+ 8 — 53								Good	— 41 — 51	UP	K 1069
K 1073	G 15	K 272, shallower, same location.	133	+ 32 — 75							— 75 —101	Good	None		K 1073
K 1074	F 7		72	+ 43 — 29								Good	— 23 — 28	UP	K 1074
K 1077	P 13		90	+ 24 — 36								Good	— 14 — 34	UP	K 1077
K 1086	I 1		118	+ 5 —113								Good	—103 —113	UP	K 1086
K 1089	H 8		75	+ 40 — 35								Good	— 13 — 35	UP	K 1089
K 1090	K 6	K 201, shallower, same location.	126	+ 17 —109								Good	— 93 —109	UP	K 1090
K 1091	E 13		131	+ 18 —113								Good	— 95 —105	UP	K 1091
K 1101	M 11		71	+ 45 — 26								Good	— 6 — 26	UP	K 1101
K 1102	G 15*	K 259, deeper, same location.	103	+ 35 — 68								Good	— 48 — 68	UP	K 1102

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K 1104	M 12		168	+ 43 — 93	— 93 —110	—110 —125						Fair	—113 —125	J	K 1104
K 1112	I 19		64	+ 17 — 47								Good	— 26 — 36	UP	K 1112
K 1114	Q 13		64	+ 16 — 48								Good	— 17 — 48	UP	K 1114
K 1116	P 13		64	+ 15 — 49								Good	— 17 — 49	UP	K 1116
K 1118	P 13		75	+ 27 — 48								Good	— 16 — 48	UP	K 1118
K 1119	P 13		76	+ 27 — 49								Good	— 17 — 49	UP	K 1119
K 1123	K 20		93	+ 17 — 76								Good	— 56 — 76	UP	K 1123
K 1130	K 17*	K 182, deeper, same locality.	89	+ 18 — 63	— 63 — 71							Good	— 51 — 63	UP	K 1130
K 1134	N 12	K 191, shallower, same location.	98	+ 31 — 67								Good	— 57 — 67	UP	K 1134
K 1138	I 5		148	+ 20 —128								Good	—107 —128	UP	K 1138
K 1139	O 13*	K 538, deeper, same location.	122	No log available. Hydrologic data suggests Jameco at —115											K 1139
K 1148	D 11		150	+ 11 — 86	— 86 —100	—100 —139						Good	—118 —139	J	K 1148
K 1158	H 5		79	+ 25 — 54								Good	— 34 — 54	UP	K 1158
K 1160	J 16*	K 1275, deeper, same location.	155	+ 10 — 69	— 69 — 86	— 86 —145						Fair	—125 —145	J	K 1160
K 1164	N 11		97	+ 24 — 73								Good	— 42 — 72	UP	K 1164
K 1169	G 15		107	+ 40 — 67								Good	— 56 — 67	UP	K 1169
K 1178	H 18		72	+ 17 — 55								Good	— 44 — 55	UP	K 1178
K 1189	D 11	Log very poor, use K 922, same location.													K 1189
K 1190	D 14		74	+ 10 — 64								Good	— 39 — 63	UP	K 1190
K 1192	E 14		112	+ 30 — 82								Good	— 39 — 64	UP	K 1192
K 1205	F 9*	K 296, deeper, same location.	58	+ 69 + 11								Good	+ 31 + 11	UP	K 1205
K 1207	K 9*	K 300, deeper, same location.	38	+ 30 — 8								Good	+ 2 — 8	UP	K 1207
K 1209	L 9*	K 303, same location, same depth.	118	+ 14 —104								Good	— 43 — 90	UP	K 1209
K 1211	D 8*	K 308, deeper, same location.	116	+ 76 — 40								Good	— 6 — 36	UP	K 1211

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K 1214	J 16*	K 326, deeper, same location	60	+ 26 — 34								Good	— 13 — 34	UP	K 1214
K 1230	Q 13		95	+ 26 — 69								Good	— 41 — 68	UP	K 1230
K 1240	H 17		108	+ 55 — 53								Good	— 32 — 52	UP	K 1240
K 1241	H 14		143	+120 — 23								Good	— 11 — 23	UP	K 1241
K 1245	F 13*	K 650, deeper, same location	144	+ 10 —134								Poor	—132 —137	UP	K 1245
K 1246	I 16		85	+ 9 — 76								Good	— 41 — 63	UP	K 1246
K 1247	H 1		113	+ 12 —101								Good	— 96 —101	UP	K 1247
K 1248	I 14		145	+ 70 — 75								Good	— 60 — 75	UP	K 1248
K 1251	F 15*	K 117, deeper, same location	107	+ 45 — 62								Good	— 50 — 62	UP	K 1251
K 1252	M 11		61	+ 20 — 41								Good	— 35 — 41	UP	K 1252
K 1255	I 1		169	+ 10 —159								Good	—148 —159	UP	K 1255
K 1257	F 2		140	+ 6 —134								Good	—114 —134	UP	K 1257
K 1267	I 5		129	+ 20 —109								Good	—105 —109	UP	K 1267
K 1271	D 11	Veatch No. 5.	1,503	+ 5 — 96	— 96 —134	—137 —207					—207 —1,498	Good	Probably None	Br	K 1271
K 1273	K 17	Veatch No. 35.	275	+ 40 — 65	Gardiners and Cretaceous to —285. Jameco not present here. See also K 894.							Fair	— 23 — 65	UP	K 1273
K 1274	J 16*	Veatch No. 37. K 1275 same location.	165	+ 10 ?	? —140	—140 —155						Poor	—140 —155	J	K 1274
K 1275	J 16	Veatch No. 38.	175	+ 10 — 77	— 77 —117	—117 —165						Fair	—114 —165	J	K 1275
K 1279	G 17	Veatch No. 51.	316	+ 10 — 93							— 93 —306	Good	at —265 and —284	Br	K 1279
K 1283	K 18	Veatch No. 62.	240	+ 45 —195								Poor	— 7 — 30	UP	K 1283
K 1286	Q 13	Veatch No. 135.	164	+ 10 — 60	— 60 —108	—108 —154						Fair	Uncertain	J	K 1286
K 1287	I 10		161	+ 50 — 82	— 82 — 97	— 97 —111						Fair	—103 —111	J	K 1287
K 1288	H 16		102	+ 30 — 72	at — 72							Fair	— 49 — 62	UP	K 1288
K 1293	N 12		90	+ 35 — 55								Good	— 43 — 55	UP	K 1293
K 1294	J 14		101	+ 58 — 48								Good	— 43 — 45	UP	K 1294

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								Clay Member	Lloyd Sand Member	Weathered	Fresh				
K 1301	I 18		101	+ 44 — **57**								Good	— 37 — 57	UP	K 1301
K 1302	G 15	K 1314, shallower, same location	102	+ 41 — **61**								Good	— 41 — 61	UP	K 1302
K 1303	I 18	K 1333, shallower, same location	100	+ 26 — **74**								Good	— 27 — 30	UP	K 1303
K 1305	J 16*	K 1275, deeper, same location	166	+ 10 — 72	— 72 — 96	— 96 **—156**						Fair	—124 —153	UP	K 1305
K 1309	M 12		231	+ 43 —113	—113 —168	—168 —188						Fair	—173 —182	UP	K 1309
K 1313	H 16	K 1340, shallower, same location	161	+ 31 — 72	— 72 —129					—129 ? —130	at **—130**	Fair	None		K 1313
K 1314	G 15*	K 1302, deeper, same location	97	+ 41 — **56**								Good	— 28 — 56	UP	K 1314
K 1317	I 4		50	+ 14 — **36**								Good	— 14 — 34	UP	K 1317
K 1329	J 12		162	+ 46 **—116**								Good	— 76 —116	UP	K 1329
K 1331	J 12		145	+ 50 — **95**								Good	— 55 — 95	UP	K 1331
K 1332	F 13*	K 638, deeper, same location	168	+ 10 —121	—121 —129	—129 **—158**						Fair	—146 —158	J	K 1332
K 1333	I 18*	K 1303, deeper, same location	70	+ 26 — **44**								Good	— 31 — 43	UP	K 1333
K 1336	K 17		163	+ 50 — 52	— 52 **—113**							Fair	Probably None		K 1336
K 1338	K 12*	K 526, deeper, same location	200	+ 79 **—121**								Fair	— 71 —111	UP	K 1338
K 1339	L 12		165	+ 50 —115	at **—115**							Good	?		K 1339
K 1340	H 16*	K 1313, deeper, same location	155	+ 35 — 82	— 82 —120						at **—120**	Fair	— 51 — 72	UP	K 1340
K 1341	K 17		86	+ 27 — **59**								Good	— 53 — 59	UP	K 1341
K 1344	J 16*	K 1275, deeper, same location	171	+ 10 — 85	— 85 —118	—118 **—161**						Fair	—128 —158	J	K 1344
K 1343	L 11	Wrongly numbered K 1346 in G-W 8	168	+ 39 —122	—122 **—129**							Fair	— 95 —127	UP	K 1346
K 1350	I 16		93	+ 20 — **73**								Fair	— 55 — 73	UP	K 1350
K 1352	J 11*	K 528, deeper, same location	180	+ 61 **—119**								Good	?	UP	K 1352
K 1354	G 11		180	+ 60 —105	—105 **—120**							Good	?	UP	K 1354
K 1355	J 10		175	+ 46 **—129**								Good	?	UP	K 1355
K 1356	K 2		152	+ 5 **—147**								Good	—107 —128	UP	K 1356

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